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Description of a new torrent frog in the genus *Arthroleptides* from Tanzania (Amphibia, Anura, Ranidae)

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A new torrent frog in the genus *Arthroleptides* is described from the Udzungwa and Uluguru mountains in Tanzania. It is distinguished from the previously known species, *A. dutoiti* and *A. martiensseni*, by its large size, non-thickened supratympanic ridge, and more extensive webbing. A key to the three species in this endemic East African genus is presented.

INTRODUCTION

The series of block faulted highlands forming a chain on the eastern side of Tanzania are known collectively as the Eastern Arc Mountains (LOVETT, 1990). Major montane elements from south to north are the Udzungwas, Rubehos, Ukagurus, Ngurus, Ulugurus, East and West Usambaras, South and North Pares, and Taita Hills (fig. 1). The Eastern Arc Mountains are very old, consisting of basement crystalline rocks that were thrust up during the formation of the East African rift system (GRIFFITHS, 1993). It is believed that they have been biologically stable for long periods of time, during which many new species have evolved (LOVETT, 1993; FJELDSÅ & LOVETT, 1997). There is evidence that forest cover may have been in existence, continuously, for some 30 million years.

Forests on the Eastern Arc mountains are recognized for their diversity of plants and animals, and represent centers of high endemism in all groups of organisms studied (KINGDON, 1989; LOVETT, 1990).

A large proportion of the amphibians found in the forests of the Eastern Arc mountains is endemic. NIEDEN (1911) described a large torrent frog from the research station at Amani in

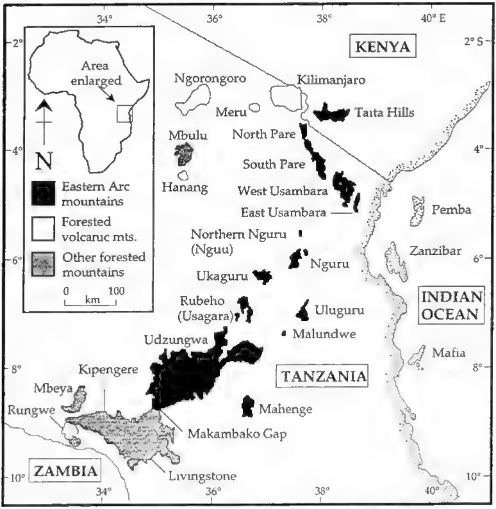

Fig. 1. Map showing the mountains comprising the Eastern Arc in Tanzania. *Arthroleptides yakusini* n. sp. is known from the Udzungwa and Uluguru mountains, and *A. martiensseni* is known from the West and East Usambaras and the Ngurus.

the East Usambaras. It was similar in many respects to the leaf litter frogs *Arthroleptis* Smith 1849, and the West African *Petropedetes* Reichenow, 1874. Nieden proposed the genus *Arthroleptides* for this frog. He named the species *Arthroleptides martiensseni*, after one of the collectors, the German military commander in Tanga. The type specimen of this species was collected at Amani, and although the specimen presented by Martienssen to the Berlin Zoological Museum had no definite locality, Nieden assumed it was also from the Usambaras. This frog was distinguishable from all others in the area by the presence of large bifid discs on the fingers and toes. C. A. Du Toit discovered a second species of *Arthroleptides* on Mt Elgon in 1934, that LOVERIDGE subsequently (1935) named *Arthroleptides dutoiti*. It was distinguished from *A. martiensseni* by the dark ventral coloration with pale spots, smaller size, and eyes that protruded beyond the jaw when viewed from below.

A. dutoiti is only known from Mt Elgon, an extinct volcano on the border between Kenya and Uganda. *A. martiensseni* has been recorded from the East Usambaras, the Ngurus, the Uluguru Mountains, and the Udzungwa Mountains in Tanzania, but fieldwork in Tanzania during 1999-2001 showed that torrent frogs from the Udzungwa and Uluguru mountain ranges were consistently separable from *Arthroleptides martiensseni* in the Usambaras. This southern form is here described as a new species.

Characters previously used to distinguish the species are reviewed, and a key is provided. KLEMENS (1998) described the extent of male secondary sexual characters in *Arthroleptides* based on a specimen from the Udzungwa Mountains. The specimen illustrated in that paper is selected as the type for the new species.

MATERIALS AND METHODS

Animals were collected in the field during 1999-2001, and photographed before being preserved. Comparative material was obtained from the collections in the Zoology and Marine Biology Department at the University of Dar es Salaam in Tanzania (UDSM and KMH numbers), the American Museum of Natural History (New York), the California Academy of Sciences (San Francisco), the Museum of Comparative Zoology at Harvard, and the Museo Tridentino di Scienze Naturali (Trento, Italy). Material with AC field numbers will be deposited in the American Museum of Natural History, specimens with RdS field numbers will be deposited in the National Museum in Washington, and specimens with ES field numbers will be deposited in the California Academy of Sciences in San Francisco. Specimens examined included tadpoles, juveniles, and large adults. The material examined is listed in app. 1, and includes 48 *Arthroleptides* n. sp. and two batches of *Arthroleptides* n. sp. tadpoles, 19 *A. martiensseni* and two batches of *A. martiensseni* tadpoles, and five *A. dutoiti*. This genus is not well represented in collections.

The measurements taken, in millimeters, include: snout length, measured from anterior corner of eye to tip of snout, horizontal diameter of eye, horizontal tympanum diameter, distance from tympanum to snout tip; maximum jaw width; snout-vent length; distance between anterior corners of eyes, length of third finger to include the palmar tubercle, length of fourth toe to include the metatarsal tubercle, length of tibia measured with the leg bent; width of forearm. The measurements were compared as ratios of tympanum-snout/tympanum, snout-vent length/tympanum, width of disc of fourth toe/tympanum, jaw width/snout-vent length, tympanum/distance between anterior corners of eyes, tympanum/eye, snout-vent length/distance between anterior corners of eyes, tibia/snout vent length, snout-vent length/third finger, snout-vent length/ fourth toe, snout-vent length/eye, forearm width/eye, and jaw/tympanum. Webbing forms a thin margin along the toes, and traditional webbing formulae (e.g. SAVAGE & HEYER 1997) based on measures of phalanges free of web are not useful. However, the amount of webbing measured from the notch between the toes ("main web") against the position of the proximal subarticular tubercle shows fixed differences between the species. The main webbing between the toes was measured against the proximal subarticular tubercles of the relevant toes. The main webbing of the fourth toe was measured on the inner and outer side.

Observations of breeding biology, including advertisement call, egg deposition sites and tadpole development were made for the new species at Kihansi in the Udzungwa mountains. Calls were recorded in the forest at 600 m in the Kihansi Gorge on the Udzungwa escarpment, using a Sony MZ-R70 recorder and an omnidirectional microphone placed at waist level in a bush near the calling individuals. A long cable permitted the observer to record the calls from five meters away. Calls were analysed using CANARY 1.2.4 (Cornell Laboratory of Ornithology, 1998) running on a Macintosh G4 or iBook. The tadpoles of the new species were compared to *A. martiensseni* tadpoles from the East Usambaras, and described using the approach of ALTIG & McDIARMID (1999).

Arthroleptides yakusini n. sp.

Holotype. A male, collected on 8 December 1995 along the Njokomoni river, Udzungwa Mountains National Park, Tanzania, 07°48'57"S, 36°51'15"E, by M. W. Klemens. The specimen, AMNH A.151342, is housed in the American Museum of Natural History.

Paratypes. – Three specimens collected at the same time and place as the holotype, a male AMNH A.151343 and two females A.151341 and A.151344.

Other material. Specimens assigned to this species are listed in app. 1.

Diagnosis. A large frog, exceeding 70 mm SVL in exceptional males, and 54 mm or over in 13 of 14 adults examined. The new species is distinguished from *Arthroleptides dutoiti* by its larger size, over 35 mm SVL in mature males (less than 25 mm in *A. dutoiti* males), webbing more extensive, with the main web reaching or passing the proximal subarticular tubercle on both sides of the fourth toe (never reaching in *A. dutoiti*) ($P < 0.0001$, Mann-Whitney U test). The posterior edge of the supratympanic ridge is never thickened (always thickened in *A. dutoiti*).

The new species is distinguished from *A. martiensseni* by more extensive webbing ($P < 0.0001$, Mann-Whitney U test) with the main web always reaching or passing the proximal subarticular tubercle of the fourth toe (only reaching in one specimen of 20 examined in *A. martiensseni*, falling far short in the other specimens).

Description of the holotype. Comparative measurements of the holotype and the three paratypes are presented in tab. 1. The holotype is a male with well-developed secondary sexual characters, 73 mm SVL (fig. 2). The head is broad, with the maximum jaw width (32.0) 44 % of the SVL. The eyes are not visible from below. The nostrils, situated near the front of the snout, open 45° postero-laterally. The tympanum (6.6) is dark, round, ringed with small tubercles. The snout to tympanum distance is 22.9. The horizontal diameter of the tympanum is slightly less than half the distance between the anterior corners of the eyes (13.5). The tympanic papilla is black, protruding from the upper half of the tympanum. The supratympanic ridge obscures the upper posterior margin of the tympanum. This ridge is nearly

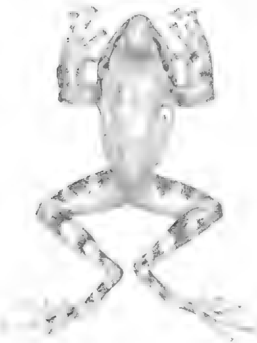

Fig. 2 Holotype of *Arthroleptides yakusini*, AMNH A 151342. Snout-vent length is 73 mm. Redrawn after KLEMENS (1998).

straight when viewed from the side, and is illustrated in KLEMENS (1998). The basal portion of the ridge is not thickened.

The forearm (10.7) is wider than the diameter of the eye (7.8). The terminal disks of the fingers and toes are large, bifid, with a pair of dorsal scutes. The width of the disk on the third finger is 50 % of the width of the tympanum (fig. 3). The third finger is 20.4 measured to the base of the palmar tubercle. The palmar, metatarsal and subarticular tubercles are well developed. The tibia (43.7) is 59 % of the SVL, and the fourth toe (38.9) is 53 % of the SVL (fig. 4). No femoral glands are present.

Webbing extends in a distinct margin along the toes. The main web reaches the middle of the proximal subarticular tubercle of the first toe, the distal edge of the proximal subarticular tubercle of the second toe, and the lower inner edge of the proximal subarticular tubercle of the third toe, passing beyond the outer edge. The main webbing passes the proximal subarticular tubercle of the fourth toe on the inside, and reaches it on the outside. Main webbing reaches the middle subarticular tubercle of the fifth toe.

The dorsum and upper limbs are gray-brown with darker mottling. The back of the thigh is speckled with white on a dark background. The throat is dark with pale speckling, while the chest and belly have a paler background with white speckles. The underside of the limbs is pale. The dorsal skin is granular, with small white-tipped warts on the side of the head. The upper and lower jaws are edged with minute dark-tipped spines.

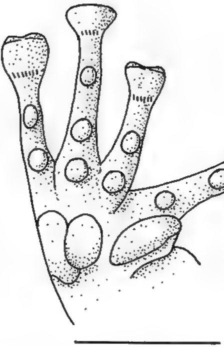

Fig. 3. – Right hand (ventral view) of *A. yakusini* AMNH A 151342. Scale line: 10 mm.

The paratypes are similar but with none of the secondary sexual characters. See tab. 1 for comparative measurements.

The type and paratypes have encysted parasites in the skin, probably mites. These are also present in sympatric *Afrana* and *Phrynobatrachus* spp. in material collected at the same time.

Other material examined. – The mean, range and standard deviation are given for the ratios investigated in tab. 2. The jaws are wide, varying between 40 and 45 % of the SVL in *A. yakusini*. The tympanum is exceptionally large in males displaying secondary sexual characters, with a dimension equal to nearly half the distance between the anterior corners of the eyes, but considerably less in smaller males and females, where the tympanum may be as small as 20 % of the distance between the anterior corners of the eyes. In large males showing spines on the chin and throat, and a ring of spines around the tympanum, the forearms are also hypertrophied, with the forearm width sometimes reaching up to 150 % the diameter of the eye. In animals not displaying secondary sexual characters, the forearm thickness is less than eye diameter, and may be as little as half eye diameter. The mean tibia/SVL proportion is 60 % in the three species, with no relationship with size or sex. The main web of *A. martiensseni* never passes the subarticular tubercle of the fourth toe on either side. In only one specimen examined, a 19.8 mm SVL juvenile from the East Usambaras, did the main web just reach the proximal edge of the subarticular tubercle of the fourth toe, and just pass the subarticular tubercle of the third toe. In contrast, the main web of 31 of 34 *A. yakusini* examined passed

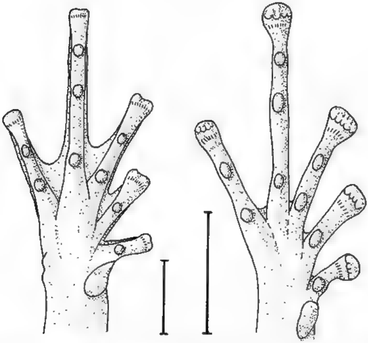

Fig 4 Right foot (ventral view) of *A yakusini* AMNH A 151342 on the left and *A martiensseni* CAS 168625 on the right. Scale lines: 10 mm.

the subarticular tubercle of the third toe, and reached or passed the subarticular tubercle of the fourth toe ($P < 0.0001$, Mann-Whitney U test). The proportions of the web and subarticular tubercles are such that there is nearly twice as much webbing in *A yakusini* as in *A martiensseni*. The digital discs vary by age and presumably by sex and reproductive status. Figure 5 illustrates the variation in the discs of the fourth toe in some specimens. The relative size of the disc, for example when compared to tympanum size, would not be useful in this genus. Work is in progress to investigate this variation. The body proportions investigated (tab. 2) show slight differences between males and females, but no significant differences between the three species.

The differences in the amount of webbing between *A yakusini* and *A martiensseni* are consistent in all specimens examined and represent an absolutely distinct character with no overlap in variation between the species.

In life, many individuals show an orange-reddish band through the upper part of the eye. The dorsal color pattern is a remarkably good camouflage against leaf litter on the forest floor. Smaller animals are nearly invisible against a wet log, for example, with only the pale digital scutes showing Some smaller animals have distinct transverse banding on the back.

Table 1. – Comparative measurements of the holotype and paratypes of *Arthroleptides yakusini*.

Status AMNH number Sex	Holotype A.151342 Male	Paratype A.151341 Female	Paratype A.151343 Male	Paratype A.151344 Female
SVL	73	57	55	56
Eye	7.8	7.2	6.2	7.1
Tympanum	6.6	3.1	4.5	3.5
Tympanum-snout tip	22.9	19.5	17.6	18.7
Jaw width	32.0	23.6	22.8	24.0
Anterior eyes	13.5	12.2	10.8	11.4
Length 3rd finger	20.4	16.9	16.3	17.3
Forearm width	10.7	4.0	5.5	4.7
Length 4th toe	38.9	32.0	28.4	30.8
Tibia	43.7	34.3	34.2	37.2
Main inner web toe 4: proximal tubercle	Passes	Passes	Passes	Reaches
Main outer web toe 4: proximal tubercle	Reaches	Reaches	Passes	Reaches

Table 2. Mean, range and standard deviation for the ratios examined in specimens of *Arthroleptides yakusini*. The overall mean is based on males, females and juveniles.

Ratio	Overall mean	Males Mean (range) *s*, *n*	Females Mean (range) *s*, *n*
Tympanum-snout / tympanum	5.64	4.36 (3.81-5.62) 0.84, 7	5.64 (4.86-6.29) 0.47, 6
Snout-vent length / tympanum	16.59	13.11 (10.80-17.08) 2.53, 7	16.63 (16.00-18.48) 0.96, 6
Jaw width / snout-vent length	0.43	0.43 (0.40-0.45) 0.02, 7	0.43 (0.41-0.44) 0.01, 6
Tympanum / anterior eyes	0.31	0.39 (0.27-0.49) 0.08, 7	0.31 (0.25-0.32) 0.02, 6
Tympanum / eye diameter	0.48	0.73 (0.73-0.85) 0.06, 4	0.48 (0.43-0.56) 0.05, 5
Snout-vent length / anterior eyes	4.92	5.01 (4.37-5.63) 0.43, 7	4.92 (4.70-5.19) 0.18, 6
Tibia / snout-vent length	0.63	0.65 (0.60-0.68) 0.03, 7	0.63 (0.59-0.69) 0.04, 6
Snout-vent length / third finger	3.50	3.29 (3.14-3.58) 0.17, 7	3.50 (3.24-3.56) 0.12, 6
Snout-vent length / fourth toe	1.86	1.77 (1.61-1.93) 0.10, 7	1.86 (1.72-2.01) 0.10, 6
Snout-vent length / eye	7.70	9.07(8.85-9.36) 0.34, 3	7.71 (7.68-8.99) 0.52, 5
Forearm /eye	0.68	0.95 (0.89-1.37) 0.23, 4	0.68 (0.56-0.94) 0.17, 5
Jaw width / tympanum	7.05	5.67 (4.85-7.25) 1.00, 7	7.06 (6.62-7.61) 0.39, 6

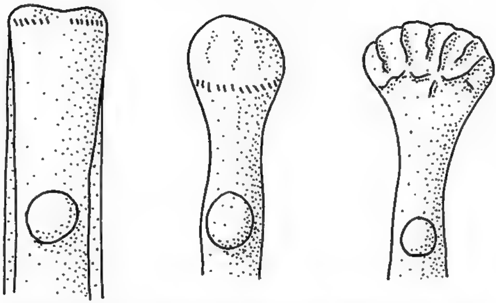

Fig. 5. Comparison of the discs of the fourth toe of *A. yakusini* AMNH A 151342 (left), *A. martiensseni* CAS 168625 (middle) and *A. yakusini* KMH 21534 (right). Similar variation was found within all populations examined.

Male secondary sexual characters. KLEMENS (1998) discussed the development of male secondary sexual characters in *Arthroleptides*. These are shared by its assumed sister group, *Petropedetes*, in West Africa. The characters include a soft tympanic papilla, spines on the chin and throat, enlarged forearms and a ring of spines around the tympanum. Unlike most frogs in the area, it appears that the males are larger than the females. Males collected out of season, smaller males and females show none of these characters (KLEMENS, 1998). The relationship between *Petropedetes* and *Arthroleptides* is under investigation. NARINS et al. (2001) investigated the function of the tympanic papilla in *Petropedetes parkeri*.

Advertisement call. Males call after the start of the short rains in November. Calling takes place after dark, from the forest floor, although males may climb on to rocks or fallen tree trunks to call. The call is a series of short "*wauks*" repeated at long intervals of up to 25 seconds. A total of 39 calls from five individuals was analysed. Calls consist of 4 to 8 pulses (mode 6) produced in 30.6 to 81.2 ms ($\bar{x}$ 60.9 ms, s 9.1, *n* 39). The resulting pulse rate varies from 73.2 to 106.5/s ($\bar{x}$ 85.7/s, s 8.5, *n* 39). The emphasized frequency varies from 1.2 to 1.4 kHz ($\bar{x}$ 1.3 kHz, s 0.04, *n* 39). A sound spectrogram of a typical call is illustrated in fig. 6.

Eggs. The following descriptions are based on observations made in January 2001 at Kihansi. The dark eggs are deposited either in small groups of four or five, or in large masses of about 200. The eggs are always attached to sloping or vertical rock faces that are covered by a film of water. Near the base of the Kihansi falls the rocks were wet from drifting spray, while

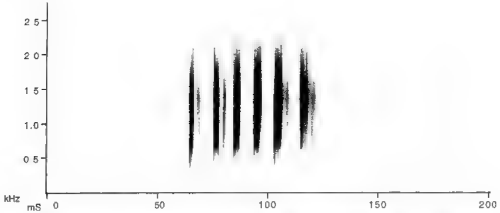

Fig. 6 - Sound spectrogram of a typical advertisement call of *Arthroleptides yakusini*, Kihansi Gorge, Udzungwa mountains, Tanzania. 24°C, 28 January 2001.

other rocks in dryer situations were wet from natural drainage from higher ground. Each egg is 2 mm in diameter, in a 4 mm capsule. The eggs are camouflaged against the dark reflective surface.

Tadpoles. Tadpoles at various stages were collected over a period of three months from the Udzungwa escarpment. They are similar in body proportions and mouthparts to the tadpoles of *Arthroleptides martiensseni* (Drewes et al., 1989, whose descriptive approach is followed here for comparison).

This description is based on a tadpole of stage 37 (AC 2452) collected in the Kihansi Gorge in the Udzungwa Mountains, Tanzania. The individual (fig. 7) has a total length of 27.4. Its other measurements and major features are: body length 8.7, tail length 18.7, body height 6.0 from snout 3.1, body width 6.0 from snout 4.7, tail muscle height at base 1.5, greatest dorsal fin height 10.0 from tail tip. The ventral fin is absent. Interorbital distance 2.3, internarial distance 1.4, snout to anterior edge of nares 0.8, snout to anterior corner of eye 1.9, snout to spiracle 5.2, posterior edge of naris to anterior corner of eye 1.0, naris diameter 0.13, eye diameter 1.3, pupil diameter 0.6 and width of oral disc 2.2. Oral disc without anterior oral papillae (fig. 8), vent medial, eyes protruding dorsally, sinister spiracle, with a labial tooth formula 3(1-3)/3(1).

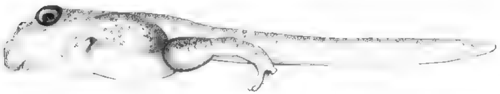

Fig. 7. A 27.4 mm tadpole of *Arthroleptides yakusini* from Kihansi, Udzungwa Mountains, Tanzania. AC 2452.

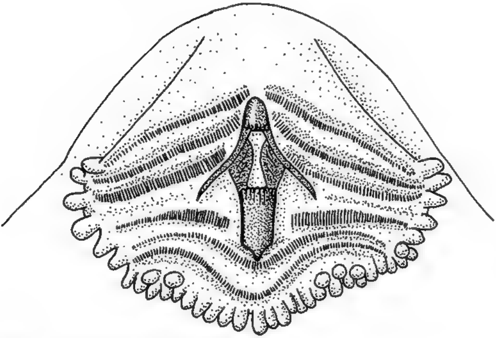

Fig. 8 – Oral disc of the tadpole of *A. yakusini* AC 2452

The labial tooth rows have about 52 teeth/mm. The upper jaw sheath is strongly curved, resembling the beak of a parrot. The lower jaw sheath is acutely curved, fitting inside the upper sheath when the jaws close. The posterior edge of the oral disc has a double row of marginal papillae, becoming single towards the angle of the jaw. The papillae are short and rounded.

The oral disc is closed in preserved specimens, similar to the illustration in DREWES et al. (1989). The upper labium is flexed to cover the lower labium. When the disc is closed the medial ends of labial tooth rows A-1 overlap.

The body is widest posteriorly in dorsal view. The dorsal fin is very reduced, as high as it is wide. The ventral fin is absent. In an earlier stage 23 tadpole (fig. 9) both fins are better developed. At this stage the external gills are still present. In specialised tadpoles like these that live on wet rocks, the timing of the loss of external gills and the development of hind legs

Fig. 9 – A stage 23 tadpole of *Arthroleptides yakusini* from Kihansi, Udzungwa Mountains, Tanzania, AC 2453, to show the dorsal and ventral fin development

for locomotion are not comparable to more typical tadpoles and it is not possible to compare stages directly. The eyes protrude dorsally. The spiracle opening is a small vertical slit 0.1 high. The vent tube is rounded, extending 0.5 beyond the hind legs, the opening not attached to the tail muscle. Femoral glands are present extending from near the knee, for 1/3 along the back of the thigh. The toes are separate with distinct discs. The bifid dorsal disc scutes are not yet developed.

The dorsal surface is dark with darker markings and pale spots. The dorsal half of the tail is much darker than the lower half. Nine light dorsal patches on the tail extend on to the sides. These are saddle-like in living specimens. Ventrally the belly has some mid-belly speckling with fine spots. All other ventral surfaces are white. Five gut spirals are just visible through the belly muscles.

Tadpoles hatch from the eggs and remain on the wet rock faces. They may occur at high densities on rock faces in a film of water, with 22 counted in one square meter below the Uluguru North Forest Reserve, grazing on algae. They complete development in the film of water, taking 8 to 10 weeks. Tadpoles were found during the day under stones in a road-side ditch at Morningside, Uluguru Mts (1 May 1980). After the tail is resorbed, juveniles leave the nursery rock and can be found feeding in vegetation along streams and in leaf litter in forest.

Etymology. The species name *yakusini* is an adjective, derived from the Swahili *ya kusini*, meaning "of the south". It refers to the distribution of this species in the mountains to the south of the range of *A. martiensseni*, with which it has long been confused.

DISTRIBUTION AND HABITAT OF THE THREE SPECIES

The three species of *Arthroleptides* are allopatric as far as is known, but further fieldwork is needed to determine their detailed distributions. *Arthroleptides dutoiti* is known from rocky streams that drain Mt. Elgon, an extinct volcano on the common border of Kenya and Uganda. Much of the forest habitat on the lower slopes has been cleared and it has been suggested that this species is extinct (DREWES et al., 1989). However, these seasonally common frogs should be looked for at the start of the rains. They are found in cracks and under large rocks on the side of steep slopes, a habitat requiring a lot of search-effort. Their eggs are large (3 mm) and pigmented, but the tadpoles are unknown.

Arthroleptides martiensseni is found in the East and West Usambaras, and Nguru mountains. It occurs both in forest leaf litter far from water, and along rocky streams. Juveniles have been found in quiet pools and seepages. The adults shelter under large boulders along fast flowing streams, emerging after nightfall to feed. The wide jaws suggest that this species and *A. yakusini* are important predators on smaller frogs like *Arthroleptis stenodactylus* Pfeffer, 1893 that are common in the forest leaf litter. The eggs are unknown, but the tadpoles of *A. martiensseni* with very characteristic mouthparts have been described (DREWES et al., 1989).

Arthroleptides yakusini is known from the Ulugaru and Udzungwa mountains from 300 m up to 2800 m. After the tadpoles metamorphose, the juveniles leave the nursery rock and move into vegetation and leaf litter to feed. They have been found in small pools along streams, or climbing on leaves on the top of vegetation. Small, non-adult individuals of *A. yakusini* are also found in cracks and fissures of vertical rock and soil faces along small streams and drying stream beds. They peer out at observers and immediately try to go deeper in if disturbed. The adults, especially the larger animals, move deep into cracks under large rocks during the day, emerging onto wet rock faces after dark to feed. Adults have been found on the forest floor some distance from water, under a rotting log on a stream bank, and occupying a crack in tree bark. Sometimes an individual will emerge and sit out on rocks just covered with shallow, fast flowing water, where it can easily escape downstream with the current. Adults are capable of large leaps.

IDENTIFICATION

The characters used by LOVERIDGE (1935) to distinguish between *A. dutoiti* and *A. martiensseni* (eyes visible from below, and dark belly with white spots) are of limited use. The jaws are relatively wider in larger animals, and the eyes may be visible from below in smaller specimens of *A. martiensseni* and *A. yakusini*. All three species have individuals with purple bellies and white spots. The following key will help identifying species of *Arthroleptides*:

1a. Base of glandular supratympanic ridge thickened, animals never over 35 mm SVL .... *Arthroleptides dutoiti*
1b. Base of supratympanic ridge never thickened, mature animals exceeding 50 mm SVL 2
2a. Web notch reaching or passing proximal subarticular tubercle of fourth toe .... *Arthroleptides yakusini*
2b. Web notch never reaching proximal subarticular tubercle of fourth toe .... *Arthroleptides martiensseni*

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APPENDIX 1
LIST OF SPECIMENS EXAMINED

The following abbreviations are used.

AC. – Field numbers of A. Channing. Material is to be deposited in the American Museum of Natural History.
AMNH. – American Museum of Natural History, New York.
CAS. – California Academy of Sciences, San Francisco.
ES. – Field numbers of E. Scott. Material will be deposited in the California Academy of Sciences.
KMH. – Field numbers of K. M. Howell, specimens in the collection of the Zoology & Marine Biology department, University of Dar es Salaam.
MCZ. – Museum of Comparative Zoology, Harvard.
MTSN. – The *Museo Tridentino di Scienze Naturali* (Trento, Italy).
RdS. – Field numbers of R. de Sa. Specimens will be deposited in the National Museum, Washington, DC.
UDSM. – The University of Dar es Salaam, collection of the Zoology and Marine Biology department.

Arthroleptides dutoiti

Five specimens from Mount Elgon, Kenya. – AMNH A 68670, A 68673, A 68675, A 68677 68678

Arthroleptides martiensseni

Altogether 19 frogs and two batches of tadpoles.

East Usambara Mountains, Tanzania. Females USDM 1107, CAS 168625, 168633, 168684, AC 2234; ES 705; ES 723. Males: CAS 168627, 168631. Juveniles AC 1905, 2045.

Segoma Forest Reserve, East Usambara Mountains, Tanzania – Male: KMH 17503. Juvenile: KMH 17549

Amani, East Usambara Mountains, Tanzania – Females MCZ A.12823 Males. MCZ A 12824.

Mt Lutind, East Usambara Mountains, Tanzania. – Female: MCZ A.12825.

Magrotto Mountain, East Usambara Mountains, Tanzania. Males. MCZ A.25380-81 Juvenile MCZ A 25382.

Zigi river, East Usambara Mountains, Tanzania. Tadpoles. CAS 168615, 168617

Arthroletides yakusini

A total of 48 frogs and two batches of tadpoles.

Njokomoni River, Udzungwa Mountains National Park, Tanzania – Males: AMNH A.151342 (holotype), A 151343 (paratype) Females AMNH A 151341, A 151344 (paratypes).

Kihansi Gorge, Udzungwa Mountains, Tanzania. - Juvenile: UDSM 1038. Tadpoles. AC.

Udzungwa Mountains, Tanzania - Males: UDSM 1116, 1138-39 Juveniles. AC 1930, UDSM 1038 (9 specimens).

Kihansi Gorge, Udzungwa Mountains, Tanzania. Juvenile AC 2379

Kitolomero, Udzungwa Mountains, Tanzania Juveniles. MTSN unnumbered (20 specimens).

Kihanga, Udzungwa Mountains, Tanzania Females: MTSN unnumbered (2 specimens)

Tegetero, Uluguru Mountains, Tanzania. Male RdS 862. Juveniles RdS 849, 866

Morningside, Uluguru Mountains, Tanzania. – Tadpoles: CAS 159944.

Bagilo, Uluguru Mountains, Tanzania. Males AMNH A 37281, MCZ A 12817, A.12820.

Vituri, Uluguru Mountains, Tanzania. – Female: MCZ A.12822

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